REMARKS

I. SUPPORTING DISCLOSURE FOR THE CLAIM CHANGES AND SPECIFICATION CHANGES

The method of new claim 17 has been limited to a method of treating the refractory material of a Danner blowpipe or a drawing die. The example on page 5, lines 9 and following of the originally filed US specification supports the limitation of the method to treating the surface of a Danner blowpipe with laser radiation. Page 1, lines 9 to 10, of the originally filed US specification supports the limitation of the refractory material to a drawing die.

The added limitation in new claim 17 that the treatment of the surface of the refractory material with the laser radiation forms a surface layer that is a closed vitreous layer is supported by page 2, lines 20 to 22, and page 4, lines 3 to 4, of the applicants' originally filed specification. Also page 4, lines 3 to 4 supports the limitation that components of the surface layer, the vitreous layer, include components of the refractory material.

Changes have also been made in the wording of the independent claims to eliminate indefinite wording and overcome the formal rejections. Changes were made in claims 2 to 9 to change their dependency to the new independent claims and provide wording that is consistent with the terms in the new independent claims.

The disclosure at page 1, lines 12 to 14, of the applicants' originally filed specification provides a basis for stating that the refractory material itself has a composition comprising or is composed of Al_2O_3, SiO_2, ZrO_2 and/or MgO or CrO. Also that point in the applicants' specification explains that the term "refractory material" encompasses several different materials: fireclay, silimanite bricks, zirconium and zirconium-containing bricks, **and/or** fusion-cast bricks. One skilled in the art would understand that, as a practical matter, a Danner blowpipe or a drawing die would not be made of all four types of refractory material. The independent claims have been drafted accordingly.

Since W/mm^2 is a power density, not an energy density (the symbol W is the symbol for "watts", which is a power unit), an appropriate change has been made in the wording of dependent claim 3. Similarly the term "feed rate" should have been translated "scan rate" and has been changed in the amended dependent claim 5. These changes would be understood and appreciated by those skilled in the art. Similar changes have been made on page 3 of the specification.

New claims 20 and 21 replace claim 16 and include wording that is similar to the wording of new claim 17.

New claims 18 and 19 are new but are supported by the subject matter of the original claim 12 and 13 respectively.

II. INDEFINITENESS REJECTIONS

Claims 1 to 9 and 16 were rejected under 35 USC 112, second paragraph, for indefiniteness.

Independent claims 1 and 16 have been canceled. New independent claims 17 and 20 replace canceled independent claims 1 and 16 respectively.

The term "light-weight refractory brick" has been deleted from the claims as an alternative for the refractory material since its scope is not defined.

New claims 17 and 20 clearly define the composition of the refractory material. The refractory material is a material of a Danner blowpipe or a drawing die, which come into contact with a glass melt during glass production. The refractory material is composed of Al_2O_3, SiO_2, ZrO_2 and/or MgO or CrO. The refractory material of the Danner blowpipe or drawing die is **at least one** of the following materials: fireclay, silimanite bricks, zirconium and zirconium-containing bricks, and fusion-cast bricks

Because of the term "zirconium and zirconium-containing" a Markush group was not used to describe the aforesaid alternatives. One skilled in the art would understand that a refractory brick cannot be made of only zirconium metal.

For similar reasons a Markush group could not be used to express that alternatives for the oxide composition of the refractory material.

The wording used in claims 17 and 20 is believed to be most consistent with the understanding of the intended scope of the term "refractory material" that

one skilled in the art would glean from the disclosures in the applicants' originally filed specification. One skilled in the art would understand that in most cases the refractory material of e.g. a drawing die would not include all four different types of brick materials, but probably only one. On the other hand, it is not inconceivable that it would include more than one type of brick material. Hence the term "and/or" is used.

Also it is believed that one skilled in the art would also understand that the recited oxide compositions do not merely apply to fusion-cast bricks but instead to the refractory material. The former interpretation is clearly the result of poor choice of word order during the English translation, because one skilled in the art knows and in fact it is common knowledge that refractory materials generally include silica and/or alumina and/or magnesia.

Although complicated the alternatives expressed with "and/or" or "or" regarding the oxide composition are definite. The size of the number of different alternatives expressed by claim wording is not a cause for indefiniteness and changes would unfairly eliminate embodiments that are justly covered by the claim. Furthermore the wording regarding the oxide composition of the refractory material is explicitly supported by line 18 of page 2 of the applicants' specification. Changes in this wording might lead to introduction of "new matter" and have been avoided.

The broadest interpretation of the wording defining the oxide composition would be that the refractory material encompasses embodiments containing at one of the recited oxides (e.g. SiO_2) and no other recited oxide but also

embodiments that contain Al_2O_3, SiO_2, ZrO_2 and another metal oxide, which is MgO or CrO. Thus the wording designating the oxide composition is definite and not confusing.

For the aforesaid reasons withdrawal of the rejections of amended claims 2 to 9 as indefinite under 35 U.S.C. 112, second paragraph, in paragraphs 9 and 10 on pages 3 and 4 of the Office Action is respectfully requested.

In addition, it is respectfully submitted that new claims 17 to 21 should not be rejected as indefinite under 35 U.S.C. 112, second paragraph, for the aforesaid reasons.

Claim 3 was rejected as indefinite under 35 U.S.C. 112, second paragraph, for indefiniteness.

Claim 3 erroneously used the term "energy density" for the power density in W/mm^2, wherein "W" represents the well-known unit of power, namely the watt.

Claim 3 has been amended accordingly to use the term "power density" since the term "energy density" would be repugnant to the actual accepted meaning in the art.

A similar change has been made in claim 5 since the so-called feed rate is better named a "scan rate" and would be understood as the rate at which the laser beam is scanned across the surface during the laser treatment.

Accordingly withdrawal of the rejection of claim 3 as indefinite under 35 U.S.C. 112, second paragraph, in paragraph 11 on page 4 of the Office Action, is respectfully requested in view of the changes in amended claim 3.

III. ANTICIPATION REJECTION

Claims 1, 3, and 6 to 7 were rejected as anticipated under 35 U.S.C. 102 (b) by Bradley, et al (Materials Science and Engineering A (2000), 204 - 212), as evidenced by Triantafyllidis, et al, which were cited with the restriction requirement.

New claim 17 replaces canceled claim 1.

New claim 1 is not anticipated by Bradley because the method is now limited to treating the refractory material of a Danner blowpipe or a drawing die. Danner blowpipes and drawing dies are not disclosed in either of the two cited prior art references.

Furthermore, the refractory materials of Bradley are used in furnaces and incinerators according to page 204, first few lines of the Introduction of the article in Materials Science and Engineering, not in glass manufacturing. The compositions of the refractory materials in Table 1 do not include ZrO_2 and include other oxides, such as K_2O and P_2O_5, which are not disclosed as included in applicants' refractory materials.

In addition, the method of claim 1 is now limited to a laser treatment that forms a closed vitreous layer with components of the refractory material itself in the vitreous layer.

Bradley discloses that the surface layer of a refractory material that is treated with a high-power CO_2 laser radiation develops cracks due to thermally-

induced stresses, although a glassy surface layer in which the pores in the otherwise porous material are sealed is produced by the treatment with laser radiation according to Bradley (conclusion on Page 212). However the cracks produced by the high power laser radiation defeats the applicants' purpose of sealing the pores, i.e. forming a closed vitreous layer, which is to prevent corrosion of the refractory material when it comes into contact with the glass melt.

To avoid the formation of the cracks in the vitreous surface layer Bradley, et al, require that the surface must be heated with an oxyacetylene torch to a high temperature in addition to the treatment with the CO_2 laser (Bradly, page 212). Triantafyllidis, et al, use a dye laser in place of the oxyacetylene torch.

In contrast, applicants have shown how to perform the sealing of the cracks with a single laser without the use of an oxyacetylene torch or a dye laser to separately heat the surface of the refractory material to a high temperature. They should be entitled to claim broadly because their claimed method is convenient since it does not require a separate heating device or laser.

Furthermore Bradley does **not** appear to disclose the feature that the surface layer that is pore-free is **vitreous**. Applicants teach at page 3, line 24, of their specification that undesirable crystal phases can form in the surface layer (similar to ceramicization).

It is well established that each and every limitation of a claimed invention must be disclosed in a single prior art reference in order to be able to reject the claimed invention under 35 U.S.C. 102 (b) based on the disclosures in the single

prior art reference. See M.P.E.P. 2131 and also the opinion in ***In re Bond***, 15 U.S.P.Q. 2nd 1566 (Fed. Cir. 1990).

Bradley does not anticipate claim 17 because:

(1) Bradley does not disclose that the closed surface layer is vitreous. Their surface layer may contain crystalline phases, especially since the development of cracks due to excessive thermal stresses is reported; and

(2) Bradley does not teach how to perform the surface treatment to form the surface layer that is a closed vitreous layer with a single laser without an auxiliary surface heating device, such as a torch or a dye laser.

With respect to claim 20 neither reference relates to glass production in which a refractory material is contacted with a glass melt. Thus neither reference teaches the step of bringing a glass melt in contact with the treated surface of the refractory material.

For the aforesaid reasons and because of the changes in the amended claim 1, withdrawal of the rejection of dependent claims 3, and 6 to 7 as anticipated under 35 U.S.C. 102 (b) by Bradley, et al (Materials Science and Engineering A (2000), 204 - 212), as evidenced by Triantafyllidis, et al, is respectfully requested.

Furthermore it is respectfully submitted that new claims 17 to 19 should not be rejected as anticipated under 35 U.S.C. 102 (b) by Bradley, et al (Materials Science and Engineering A (2000), 204 - 212), as evidenced by Triantafyllidis, et al.

IV. FIRST OBVIOUSNESS REJECTION

Claims 2 and 8 were rejected as obvious under 35 U.S.C. 103 (a) over Bradley, et al (Materials Science and Engineering A (2000), 204- 212), and further in view of Petitbon (US 4,814,575), as evidenced by Hancock, et al (US 3,929,498).

None of the references including Bradley, Pettibon, and Hancock teach a method of treating a Danner blowpipe or drawing die with laser radiation to form a closed vitreous surface layer. In fact, none of these references disclose anything regarding glass production methods and apparatus or anything regarding how to prepare the surfaces of these components to make them better able to withstand the extreme conditions that they experience when they contact a glass melt.

A Danner blowpipe is used for the continuous production of glass tubes and consists of a hollow cylinder that is arranged in a slightly inclined manner and is slowly rotated in operation. Air is blown into the interior of the hollow cylinder and the glass melt flows down the lateral surface of the blowpipe. At the lower end of the Danner blowpipe the glass melt is withdrawn from the hollow cylinder and cooled by the air flown through it.

Furthermore Petitbon does not disclose that the laser treatment forms a completely vitreous surface layer without any cracks or pores, but only promises to minimize porosity. In fact Petitbon discloses that it is advantageous to leave some microcracks in the ceramic article to "maintain toughness" at column 3, lines 3 to 7, of Petitbon. This is the opposite from applicants' claimed method, which forms a completely closed vitreous surface on the refractory material.

It is well established that a prior art reference that teaches the opposite from a claimed invention cannot be combined with another prior art reference under 35 USC 103 (a) to reject a claimed invention as obvious. See MPEP 2145 and the Federal Circuit Court of Appeals has said:

> "That the inventor achieved the claimed invention by doing what those skilled in the art suggested should not be done is a fact strongly probative of nonobviousness." in ***Kloster Speedsteel AB v. Crucible Inc.,*** 230 U.S.P.Q. 81 (Fed. Cir. 1986), on rehearing, 231 U.S.P.Q. 160 (Fed. Cir. 1986)

The reference Petitbon teaches that the surface layer should not be closed (forms microcracks).

In addition, Petitbon does not disclose or suggest that the surface layer is completely vitreous, i.e. does not have any crystalline phases.

Hancock was only cited to establish the melting point of zirconia, but does not disclose any information regarding methods of treating the surface of a ceramic or refractory with laser radiation.

The subject matter of dependent claims 2 and 8 include the subject matter of the new independent claim 17 because they depend on that independent claim. Thus the argumentation regarding the features of claim 17 here is relevant

since it is part of the rejected subject matter. Petitbon and Hancock must supply the features and limitations that are not supplied by Bradley for a valid obviousness rejection, but they do not.

For the aforesaid reasons and because of the additional limitations in the independent claim 17, withdrawal of the rejection of dependent claims 2 and 8 as obvious under 35 U.S.C. 103 (a) over Bradley, et al (Materials Science and Engineering A (2000), 204- 212), and further in view of Petitbon (US 4,814,575), as evidenced by Hancock, et al (US 3,929,498) is respectfully requested.

Furthermore it is respectfully submitted that new claim 17 and the claims dependent on it should not be rejected as obvious under 35 U.S.C. 103 (a) over Bradley, et al (Materials Science and Engineering A (2000), 204- 212), and further in view of Petitbon (US 4,814,575), as evidenced by Hancock, et al (US 3,929,498).

V. SECOND OBVIOUSNESS REJECTION

Claim 9 was rejected as obvious under 35 U.S.C. 103 (a) over Bradley, et al (Materials Science and Engineering A (2000), 204-212), and further in view of Brennen, et al (US 4,415,672).

Brennan like Bradley does not disclose that it is desirable to temper a refractory material after it has been treated with laser radiation. The laser radiation itself is a heat treatment like tempering. Thus one skilled in the art might well assume that the refractory material had been tempered by the laser radiation.

Furthermore Brennan does not cure the deficiencies regarding Bradley regarding the subject matter of method claim 17. Claim 9 depends on claim 17 so that in order for a valid rejection of claim 9 based on a combination of the subject matter of Bradley and Brennen, Brennan must suggest the modifications of the subject matter of Bradley that are necessary to arrive at the subject matter of applicants' claim 17 with the new limitations.

However since Brennan does not disclose anything regarding high power laser treatments of the surface of refractory material, Brennan cannot suggest a method of treating the surface of a refractory material to form a completely closed completely vitreous surface layer, as now claimed in applicants' claim 17.

As a result of the dependence of claim 9 on claim 17 primarily, the combined subject matter of Bradley and Brennan do not establish a case of *prima facie* obviousness of claim 9.

For the aforesaid reasons and because of the new limitations in the method according to independent claim 17, withdrawal of the rejection of claim 9 as obvious under 35 U.S.C. 103 (a) over Bradley, et al (Materials Science and Engineering A (2000), 204 - 212), and further in view of Brennen, et al (US 4,415,672) is respectfully requested.

Furthermore it is respectfully submitted that new claim 17 and the claims dependent on it should not be rejected as obvious under 35 U.S.C. 103 (a) over Bradley, et al (Materials Science and Engineering A (2000), 204 - 212), and further in view of Brennen, et al (US 4,415,672).

VI. THIRD OBVIOUSNESS REJECTION

Claim 16 was rejected as obvious under 35 U.S.C. 103 (a) over Elliot, et al, (US 5,659,564) in view of Bradley, et al (Materials Science and Engineering A (2000), 204-212).

Claims 20 and 21 replace canceled claim 16. Claim 20 includes the new limitations added to the independent laser treatment method claim, i.e. claim 17.

Elliot discloses an oxygen-boosted and oxy-fuel fired furnace for melting glass, which has a heated bushing in the vicinity of the outlet in order to reduce the problems involved in cleaning slag out of the furnace. Elliot does disclose that the slag running down the refractory walls of the furnace will erode the refractory material.

However the solution of Elliot does not involve treatments to improve the resistance of the surface of the refractory walls to reduce their erosion by the glass slag.

Bradley does disclose a treatment of the refractory material of incinerators (introduction) to seal the pores of the refractory material to prevent corrosion or erosion by slag. However the laser treatment according to applicants' new claim 20 is different from that of Bradley because it produces a closed vitreous layer as explained above in the case of claim 17. The layer of Bradley is not necessarily completely vitreous. Furthermore Bradley teaches that crack formation is problem when only laser radiation from a single CO_2 is used to prepare the surface layer as in the case of applicants' method.

One skilled in the art would not be able to predict that the laser treatment of the surface of the refractory material led to a surface that solved the erosion problem in the case of the glass melt or slag because the temperatures involved in processing a glass melt are often higher than those present in incinerators.

When predictability is lacking, a case of *prima facie* obviousness is not established by the references (MPEP 2142 to 2143).

For the aforesaid reasons and because of the additional limitations in claim 20, it is respectfully submitted that claims 20 and 21 should not be rejected as obvious under 35 U.S.C. 103 (a) over Elliot, et al, (US 5,659,564) in view of Bradley, et al (Materials Science and Engineering A (2000), 204 - 212).

Should the Examiner require or consider it advisable that the specification, claims and/or drawing be further amended or corrected in formal respects to put this case in condition for final allowance, then it is requested that such amendments or corrections be carried out by Examiner's Amendment and the case passed to issue. Alternatively, should the Examiner feel that a personal discussion might be helpful in advancing the case to allowance, he or she is invited to telephone the undersigned at 1-631-549-4700.

In view of the foregoing, favorable allowance is respectfully solicited.

Respectfully submitted,

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